

Interreg

Greece-Bulgaria

E.VE.CR.I local

European Regional Development Fund



D 3.2

EUROPEAN AND BULGARIAN CHARGING OPERATORS

Blagoevgrad / Thessaloniki / Sofia 2023

Alliance of the Producers of Ecological Energy (SPEE-BG)

**Centre for Research and Technology Hellas - Hellenic Institute of
Transport – GR (CERTH-HIT)**

Bulgarian Electric Vehicles Association – BG (BAEPS)

AKNOWLEDGEMENT

Project “Electric Vehicles and Charging Crossborders Infrastructure” with Acronym E.VE.CR.I. and Subsidy Contract No.B6.3a.01/13.04.2021.

The Project is co-funded by the European Regional Development Fund (ERDF) and by national funds of the countries participating in the Cooperation Programme Interreg V-A “Greece-Bulgaria 2014-2020” .

DISCLAIMER

The contents of this document are sole responsibility of SPEE, CERTH and BAEPS, and can in no way be taken to reflect the views of the European Union, the participating countries the Managing Authority and the Joint Secretariat.

www.local-e.eu



DELIVERABLE DOCUMENTATION SHEET

DELIVERABLE	D3.2. European & Bulgarian Charging Operators
WORK PACKAGE	WP3 Studies & Analysis
EDITORS	AVS EOOD (Subcontractor of SPEE-BG) and MPlegal (Subcontractor CERTH -HIT)
CONTRIBUTORS	TAMVAKOS Athanasios (CERTH-HIT), SERAFIMOV Petar (BAEPS)
PEER REVIEW	ZAIMOV Martin (BAEPS)
TYPE	Study
VERSION	1.0 / 28.02.2023
COPYRIGHT	© E.V.E.C.R.I. Project The text, figures and tables in this report can be reused under a provision of the Creative Commons Attribution 4.0 International License.
DISCLOSURE STATEMENT	While the information contained in the documents is believed to be accurate, the authors(s) make no warranty of any kind with regard to this material including, but not limited to the implied warranties of merchantability and fitness for a particular purpose. Neither the E.V.E.C.R.I. Beneficiaries nor any of its members, their officers, employees or sub-contractors shall be responsible or liable in negligence or otherwise howsoever in respect of any inaccuracy or omission herein. Without derogating from the generality of the foregoing neither the E.V.E.C.R.I. Beneficiaries nor any of its members, their officers, employees or sub-contractors shall be liable for any direct or indirect or consequential loss or damage caused by or arising from any information advice or inaccuracy or omission herein.

QUALITY MANAGEMENT

28.02.2023	<input checked="" type="checkbox"/>
02.03.2023	<input checked="" type="checkbox"/>
06.03.2023	<input checked="" type="checkbox"/>

Approved by WP Leader [TSETZINAS Ioannis]

Approved by the Common Management Team

Approved by the Lead Beneficiary [ARSOV Ivo]

PROJECT DOCUMENTATION SHEET

PROJECT ACRONYM	E.VE.CR.I.
PROJECT FULL TITLE	Electric Vehicles and Charging Crossborders Infrastructure
SUBSIDY CONTRACT	B6.3a.01/13.04.2021
PROJECT DURATION	24 months [13 April 2021 – 12 April 2023]
PRIORITY AXIS	01: A Competitive and Innovative Cross-Border Area of the Cooperation Programme INTERREG V-A GREECE-BULGARIA 2014-2020
CALL IDENTIFIER	6th CALL for Project Proposals
PROJECT OFFICER	Jenya DINKOVA
LEAD BENEFICIARY	Alliance of The Producers of Ecological Energy – BG (SPEE-BG)
PROJECT BENEFICIARY 2	Centre for Research and Technology Hellas - Hellenic Institute of Transport – GR (CERTH-HIT)
PROJECT BENEFICIARY 2	Bulgarian Electric Vehicles Association – BG (BAEPS)
WEBSITE	https://local-e.eu
SOCIAL MEDIA	#evecri #local-e

ABBREVIATIONS

AC	Alternating Current
ACEA	European Automobile Manufacturers' Association
BEV	Battery Electric Vehicle
CEF	Connecting Europe Facility
CCS	Combined Charging Stations
CPO	Charge Point Operator
DC	Direct Current
DCFC	Direct Current Fast Charging
ECA	European Court of Auditors
EP	European Parliament
EVC	Electric Vehicle Charger
EVECRI	Electric Vehicles and Charging Crossborders Infrastructure
EVS	Electric Vehicle Stations
LPG	Liquid Petroleum Gas
PHEV	Plug-in Hybrid Electric Vehicle
SME	Small and Medium Enterprise

ABSTRACT

This Report provides more details about building up the charging infrastructure and installation of charging stations in the eligible regions of Greece (Macedonia & Thraki) and Bulgaria (regions of Blagoevgrad, Smolyan, Kardzhali and Haskovo), which are in the areas of operation of the EVECRI project.

The Report includes information on the current status of e-mobility in Greece and Bulgaria compared to the EU Member States and in respect to the requirements and goals introduced by the European Parliament and European Commission.

As far as the Members of the European Parliament set minimum mandatory national targets for deployment of infrastructure for alternative fuels and the Member states have to present their plans on how to achieve these targets by 2024, on one side, on the other side the European Commission sets an interim target of at least 30 million zero-emission vehicles by 2030 and almost entirely zero-emission fleet by 2050, in order to realize them, the sales of electric cars should increase considerably in all countries of the European Union.

Although the sales of EVs began to increase faster, the building of adequate charging infrastructure needs to catch up with the temps of the sales in order charging of these cars to be easily and quicker as refueling.

In the Report are included topics as Operators and Manufacturers in Greece and Bulgaria, Business Models from the Greek and Bulgarian perspectives, and Needs Analysis for EV Charging. In a separate section 5 cross border initiatives (Petrich and Sandanski to Serres/Sidirokastro, Gotse Delchev to Drama and Kavala, Smolyan and Zlatograd to Xanthi, Kardzali to Komotini, Svilengrad to Alexandroupoli) are presented.

TABLE OF CONTENTS

INTRODUCTION	8
I. CHARGING STATIONS IN EUROPE	10
II. E-MOBILITY IN GREECE	13
2.1. Operators in Greece	17
2.2. Manufacturers in Greece.....	17
2.3. The case of Macedonia & Thraki	18
2.4. Business Models from the Greek perspective	18
III. E-MOBILITY IN BULGARIA	20
3.1. Operators in Bulgaria.....	24
3.2. Manufacturers in Bulgaria	26
3.3. Business Models from the Bulgarian perspective	27
3.4. Cost structure of business operators and way of pricing services.....	28
3.5. Mapping of power stations in Bulgaria.....	30
3.6. Demand Forecasting for EV Charging (Needs Analysis).....	33
IV. SPECIFIC AREAS OF STUDY (BULGARIA-GREECE CROSSBORDER)	36
Itinerary - Petrich and Sandanski to Serres/Sidirokastro	36
Itinerary - Gotse Delchev to Drama and Kavala.....	37
Itinerary - Smolyan and Zlatograd to Xanthi	38
Itinerary - Kardzali to Komotini.....	39
Itinerary - Svilengrad to Alexandroupoli	40
V. BIBLIOGRAPHY	41

TABLE OF FIGURES

Table 1: Available charging technology.....	9
Table 2: Charging points for ECVs per country and % of EU total (2021)	11
Table 3 e-mobility trend in Greek market	14
Table 4 e-mobility trend in Macedonia & Thrace, in absolute numbers	14
Table 5: Locations and Station units per operator in Bulgaria.	21
Figure 1: DC fast charging stations in Greece.....	15
Figure 2: AC charging stations in Greece.....	16
Figure 3: Business Model Canvas for Hotels.....	19
Figure 4: Business Model Canvas for Restaurants & Coffee shops	19
Figure 5: Business Model Canvas for Super Markets.....	20
Figure 6: AC charging stations in Bulgaria	23
Figure 7: DC fast charging stations in Bulgaria	24
Figure 8: Itinerary - Petrich and Sandanski to Serres/Sidirokastro	36
Figure 9: Itinerary - Gotse Delchev to Drama and Kavala.....	37
Figure 10: Itinerary - Smolyan and Zlatograd to Xanthi	38
Figure 11: Itinerary - Kardzali to Komotini.....	39
Figure 12: Itinerary - Svilengrad to Alexandroupoli	40

INTRODUCTION

The "Green Pact" envisages approximately 13 million zero- and low-emission vehicles on European roads by 2025. In its 2020 Sustainable and Smart Mobility Strategy, the European Commission sets an interim target of at least 30 million zero-emission vehicles by 2030 and towards an almost entirely zero-emission fleet by 2050, which represents a significant increase over the approximately 2 million EVs currently registered in the EU. In addition, a growing number of Member States (including Denmark, Ireland, the Netherlands, Slovenia and Sweden) have announced plans to ban fossil fuel car sales from 2030 onwards.

Outside the EU, in Norway, the world's largest electromobility market, EVs account for 15% of all passenger cars in the EU and the UK). Norway has set the most ambitious target, requiring all new passenger cars and vans to be zero-emissions as early as 2025.

In order to realize the goals of carbon indifference and to achieve the goals of reducing carbon emissions, the sales of electric cars should increase considerably in all countries of the European Union.

Investing €58.8 billion in R&D annually, the automotive sector is the largest private in Europe contributor to innovation, accounting for 32% of total EU spending.

"If we want to convince citizens in Europe to switch to electric cars in the next decade, charging these cars must be as easy as refueling today," the European Automobile Manufacturers' Association (ACEA) states categorically, emphasizing that "people don't have to travel miles to find a charging station, nor they have to wait endlessly to charge their car."

To make the European Union truly climate neutral, the European Parliament (EP) is demanding that by 2026 at least one electric charging station will be there on every 60 km of main roads and that more powerful stations will be deployed. There will be some exceptions to the rules, namely for the outermost regions, islands and roads with very little traffic.

In October 2022 The EP adopted its position on draft EU legislation which aims not only to encourage the deployment of electric charging stations but also alternative fuels (such as hydrogen in place for every 100 km) for cars, trucks, trains and planes, to - low emissions from ships and to support the uptake of sustainable vehicles.

Members of the European Parliament set minimum mandatory national targets for deployment of infrastructure for alternative fuels. Member states will have to present their plans on how to achieve these targets by 2024.

According to data provided by ACEA, in 2019, 89.4% of all new vehicles registered in the EU run on gasoline or diesel fuel, hybrid electric vehicles are up to 6%, electrified vehicles (EVs) — 3%, and all other vehicles using alternative fuels (e.g. gas or hydrogen) only 1.6%. In 2020, the plug-in vehicle segment (battery electric cars and plug-in hybrid cars) significantly increased its market

share amid a general decline in new passenger car registrations due to the outbreak of the COVID-19 pandemic.

In 2020, EVs accounted for 10.5% of new car registrations. In other words, every tenth passenger car sold in the EU in 2020 was electric. Car manufacturers' forecast is that EV production in Europe will increase sixfold between 2019 and 2025, reaching more than 4 million cars and vans per year — or more than a fifth of EU car production volume.

Again, according to ACEA, the unsatisfactory charging infrastructure in the European Union could halt the progress of electromobility.

But it is not the only thing that there is an insufficient number of electric charging points along the road networks in the many countries of the European Union. Another problem that stands out is the lack of fast charging stations for this type of transport, that is, the majority of the charging infrastructure does not charge satisfactorily quickly.

"If we want to convince residents across Europe to switch to e-mobility in the coming decade, charging these cars should be as simple as refueling today" and "Neither people should travel miles to find a charger, nor they should wait years to charge their vehicle." added from ACEA.

Since compared to traditional vehicles, the range of EVs is still lower — about 380 km (average of the mileage of 10 light EVs currently on the market), they need to be charged more often. The charging time depends on the vehicle battery and the capacity of the charging point (see the table below).

While "slow" and "normal" chargers are better suited to home and office charging cycles, "fast" and "ultra-fast" chargers are better suited to highways and major road networks. Range restrictions and concerns about the availability of charging stations along their route can lead to "range and wait anxiety" among EV users — the fear that their vehicle will not have enough range to reach their destination and that charging can mean long queues if the charging station is already busy.

The available charging technology is shown below in the table:

Table 1: Available charging technology

Charger speed and type	Power	Estimated charging time*
Slow (single-phase alternating current (AC))	3-7 kW	7-16 hours
Normal (three-phase alternating current (AC))	11-22 kW	2-4 hours
Fast (direct current (DC))	50-100 kW	30-40 min.

Ultrafast (direct current (DC))	>100 kV	<20 min.
---------------------------------	---------	----------

**Also depends on battery capacity and other variables.*

Each member state is responsible for the preparation and implementation of its own internal policy in the field of alternative fuels according to the framework established by EU legislation. This could include measures such as tax breaks or subsidies for the purchase of electric vehicles and the construction of charging infrastructure.

I. CHARGING STATIONS IN EUROPE

In practice, charging stations are classified as level 1, 2 and 3 stations. Level 1 and 2 charging stations are conventionally called conventional and accelerated charging stations. These charging stations provide the necessary alternating voltage for the on-board charger of the electric vehicle with a maximum load of 15 A for levels 1 and 3, and 2 A for level 2.

Level 1 stations are primarily intended for home (garage) use.

Level 2 includes charging stations intended for general use, which, in addition to the adaptation of the electrical parameters of the power supply network to the electrical and structural parameters of the electric vehicle, also ensure the implementation of additional functions such as a report of the consumed electrical energy and its valuation; accepting orders for recharging electric cars; security functions; informational inquiries about the electric car and the state of the battery; communication dialogue with the supplier of electric energy or the operator of the charging stations and others.

Level 2 stations are suitable for public charging, for example in public car parks, supermarket car parks, airports, railway stations, metro stations, company car parks, etc. For level 1 and 2, in most cases no investment in the power grid is required, and the available reserves in the power grid can provide the power they need to supply.

Level 3 stations are designed for fast charging. Duration is from 10 to 30 minutes. The main difference between level 2 and level 3 is that level 3 provides constant voltage to recharge the battery of the electric vehicle. According to the experts, the required electrical power to power such a charging station is approximately from 50 to 400 kW depending on the functional electrical architecture of a charging station - single-subscriber and multi-subscriber.

Such electrical provision cannot always be provided by the available electricity transmission network and the construction of this type of stations is accompanied by new design and construction. Level 3 charging stations provide a technical possibility to become a cell of the

"smart grid" system. Level 3 charging stations replace 8 to 20 level 2 stations. They are designed to accommodate large flows of users.

The table below shows for each EU member state the number of charging stations and their share in % of the total number of stations for 2021:

Table 2: Charging points for ECVs per country and % of EU total (2021)

Country	Chargers	% of EU total	Country	Chargers	% of EU total
Austria	13,110	4.3%	Italy	23,543	7.7%
Belgium	13,695	4.5%	Latvia	420	0.1%
Bulgaria	531	0.2%	Lithuania	207	0.1%
Croatia	1,730	0.6%	Luxembourg	1,782	0.6%
Cyprus	57	0.02%	Malta	98	0.03%
Czech Republic	2,189	0.7%	Netherlands	90,284	29.4%
Denmark	5,752	1.9%	Poland	2,811	0.9%
Estonia	385	0.1%	Portugal	4,124	1.3%
Finland	5,497	1.8%	Romania	1,161	0.4%
France	37,128	12.1%	Slovakia	1,367	0.4%
Germany	59,410	19.4%	Slovenia	1,309	0.4%
Greece	514	0.2%	Spain	10,480	3.4%
Hungary	2,541	0.8%	Sweden	25,197	8.2%
Ireland	1,542	0.5%	EU total	306,864	

Source: EAF0

By 2022 there are just over 377,000 charging stations in the EU. This is half of the amount that would be achieved if member states had fulfilled their pledges in time. Europe needs to address this obstacle to decarbonisation and rapidly roll out alternative fuel infrastructure. Only in this way will the "Green Pact" aimed at reducing carbon emissions be achieved.

Only 5 countries have more than 10 charging stations every 100 km. Among them are the Netherlands (64), Luxembourg (58), Germany (26), Portugal (25) and Sweden (12).

In the ACEA ranking, the leader is the Netherlands with a market share of electric cars of 29.5% and with 64.3 charging stations per 100 km.

Six European Union countries do not have a single charging station within 100 kilometers of their main roads – these are Lithuania, Cyprus, Greece, Estonia and Poland.

17 countries have less than five charging stations per 100 km of road, including Bulgaria.

Unfortunately, there is still a large gap in the EU between the countries with the most charging stations per 100 km of road and those with the fewest. There is a great gulf between the parties. For example, the Netherlands has one charger every 1.5 km of road, while Poland – which is eight times larger – only has one charger every 150 km.

Charging speed is also a major issue across the continent, with fast chargers (with potential over 22kW) making up a tiny fraction of the total. In fact, only one in seven of all charging points in the European Union is fast. All others have a potential of 22kW or less and do not charge vehicles at the permitted speed.

According to an ACEA analysis, the entire EU, out of 9 charging stations for electric cars, only 1 is from the so-called fast. More specifically, at the end of 2020, when the latest data is available, a total of 224,237 such devices were installed in the 27 Member States. Of these, 199,250 are ordinary, and 24,987 are express, which means that their share is 11.1%. In Bulgaria, however, it is 39.2 percent. Or in other words, out of 194 installed charging stations for e-cars, 76 are for fast charging. Thus, in percentage terms, our country occupies the prestigious 5th place, with only Estonia, the Czech Republic, Lithuania and the leader Latvia ahead of us in the ranking.

Estonians have 176 fast and 223 slow charging stations, or the share of the former is 44.1%. Among the Czechs, it is 50.8 percent, correspondingly, the fast are even more in number than the slow - 610 against 590. Such a situation is also observed among the Lithuanians, who have 74 slow and 100 fast, whose share is 57.5%. And in Latvia, things are already very impressive. There, out of a total of 291 charging stations for electric cars, 235 or 80.8 percent are fast.

1. Top Operators in Europe

In the year 2019 were 550000 new electric cars registered across Europe. The next year their number increased to 1,325,000 cars¹. The difference between these two years is more than 50%. At the end of 2021, the battery electric and the plug-in hybrid cars together represent almost 19% of the new cars in Europe.

In 2020, there were roughly 285,800 public charging stations for electric vehicles in Europe (including Turkey) (Statista, s.d.). Almost 250,000 of those devices are considered as slow chargers with power below 22kW. Approximately 36,000 chargers are considered as DC fast chargers.

There are hundreds of charger operators across Europe as some of the largest being:

Enel – One of the largest European power companies which operates over 30,000 charging points in Europe.

Fortum – The Nordic power company which operates over 25,000 charging points across Europe.

Allego – Allego operates more than 26,000 charging stations across Europe. The company was established in 2013 in the Netherlands. It is known as one of the most rapidly growing charging networks in Europe. The enterprise is part of Meridiam group. Allego provides charging services

¹ European Environment Agency [<https://www.eea.europa.eu/ims/new-registrations-of-electric-vehicles>]

for cities, consumers, and small businesses. Their network is suitable for eclectic cars, busses, motorcycles, and trucks.

Evbox – Evbox operates around 10 000 charging stations for electric vehicles across Europe. The operator has developed its network in almost every country that is part of the European Union. The company was/has started in 2010 and the headquarters are located in Amsterdam. In 2017 Evbox was acquired by the French electric utility group ENGIE. Today ENGIE remains the biggest stakeholder in Evbox with its 40%. The major goal of Evbox is to operate 1,000,000 charging points across the world by the end of 2023.

Ionity – the company has provided 1,600 high power chargers in 401 locations along highways in 24 countries in Europe. Ionity was founded by BMW group, Daimler AG, Ford Motor Company and Volkswagen Group, in 2020 Hyundai joined them. . The goal of the company is to operate at least 7,000 fast and ultra-fast charging by the end of 2025 and to provide an opportunity for the electric vehicle owners to cross the continent with no difficulties and without waiting.

The Netherlands is the leading country in Europe with more than 63,000 slow chargers on Dutch soil². Germany has the biggest share of fast chargers with more than 40,000 public charging stations.

The difference between AC charging and DC charging is the location where the AC power gets/is being converted - inside or outside the car. A DC charger has the converter inside the charger itself. That means that it can feed power directly to the car's battery and doesn't need an onboard charger to convert it. An AC charger feeds AC power into the car's converter. The usual AC charging power is 22 kW, depending on the car model and the converter allows, in the most cases, less than 10 kW charging.

Today we can observe a big increase in the number of publicly accessible DC chargers. Between 2019 and 2020 there is a 55% increase according to the global EV outlook³. At the same time the number of AC stations also continues to grow.

The demand for DC stations is going to increase if we consider the features and larger batteries of new electric vehicles. They are becoming more and more popular and logically the users will expect a good infrastructure that allows them to recharge as quickly as possible, especially close to motorways.

II. E-MOBILITY IN GREECE

² Global EV Outlook 2021, *International Energy Agency*, p. 39.

³ Idem as pt.2

E-mobility in Greece is quite new and it is slowly growing. Even so, despite that in the last years the sales of passengers' cars have been reduced because of COVID-19 pandemic, the EV market had a notable increase (Table 3). Based on the official statistics, an increase can be observed from 0.3% of BEV & PHEV in 2018 to 8.5% in 2021. This trend is expected to be more aggressive in the next years. The penetration of BEV and PHEV in Greek market is expected to be higher than 20% in 2023. The main reasons for this growth is the fact that the EV market is increasing worldwide and it is due to the incentives that Greek government applies to support the e-mobility in Greece from 2020 and renews every year.

Table 3 e-mobility trend in Greek market

	2018	2019	2020	2021	
Passenger Cars [volume]	103,431	114,109	80,977	81,758	
BEV & PHEV [%]	0,3%	0,4%	2,5%	8,5%	
BEV & PHEV [volume]	310	480	2,100	6,950	Total: 9,840

In the Table 3 the volume of sales of BEV and PHEV in Greece is presented for the last 4 years, which is around 9,840 EVs until the end of 2021. From these vehicles 3,133 are BEV. Moreover, there are other 1,000 EVs that are available as second hand and currently are being sold in Greece. The majority of EVs has been sold in Athens and around it but lately the Greek countryside also started to contribute significantly to the EV sales.

In Macedonia & Thrace the absolute number of BEV and PHEV that were registered until the end of 2021 is 369. Even if this number is relatively small, it is noticed that the sales got tripled from 2020 to 2021 (Table 4). This trend is expected to be maintained creating a geometric progression for the near future.

Table 4 e-mobility trend in Macedonia & Thrace, in absolute numbers

	2018	2019	2020	2021	
BEV [volume]	7	6	40	74	
PHEV [volume]	18	21	48	155	
BEV & PHEV [volume]	25	27	88	229	Total: 369

The charging stations in Greece are following the sales' trend of electrified vehicles. Even if there are not official records for the number of charging stations in Greece, studying several sources, it can be said that from less than 100 charging points of every type in 2018, Greece has now more

than 100 DC fast charging stations and more than 1,200 AC charging stations in the whole country. Below the maps of charging stations in Greece are presented (www.plugshare.com, n.d.).

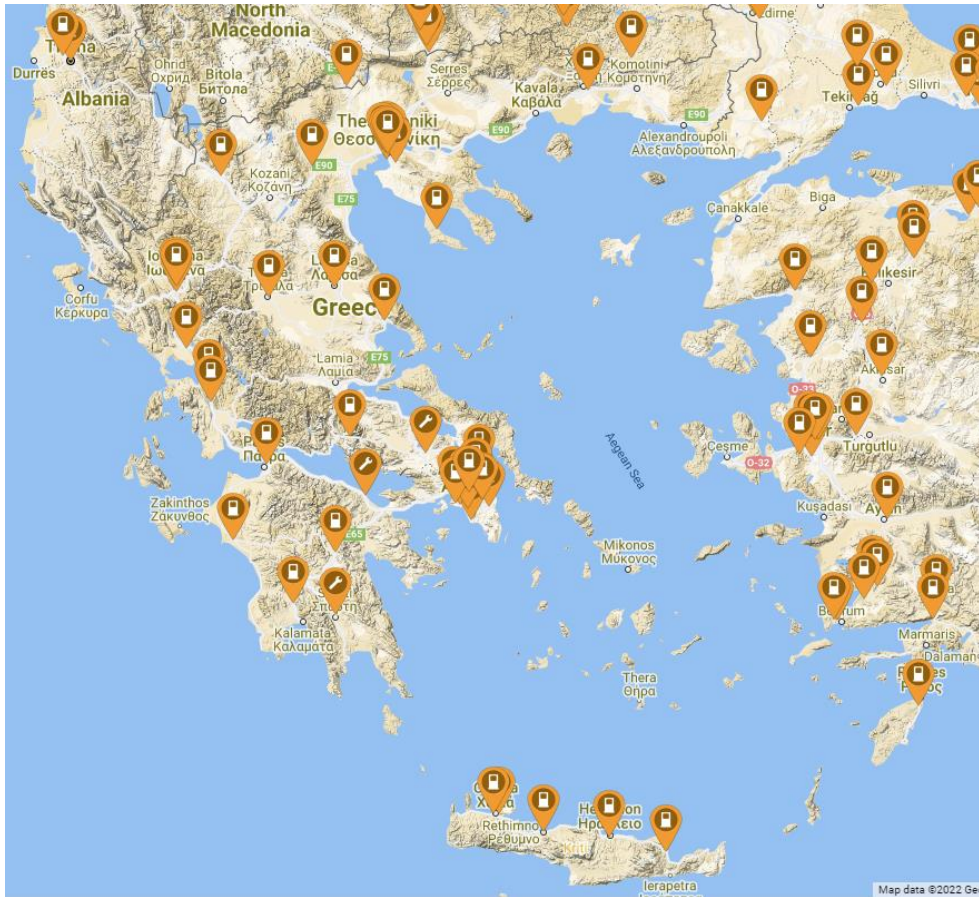


Figure 1: DC fast charging stations in Greece

The majority of DC fast charging stations are located in Athens. The second highest density of DC charging stations is at Thessaloniki. There are also many fast charging stations that are under construction in Greece. In general, the DC fast charging station is a more expensive investment and the construction requires detailed technical specifications and time to be done.

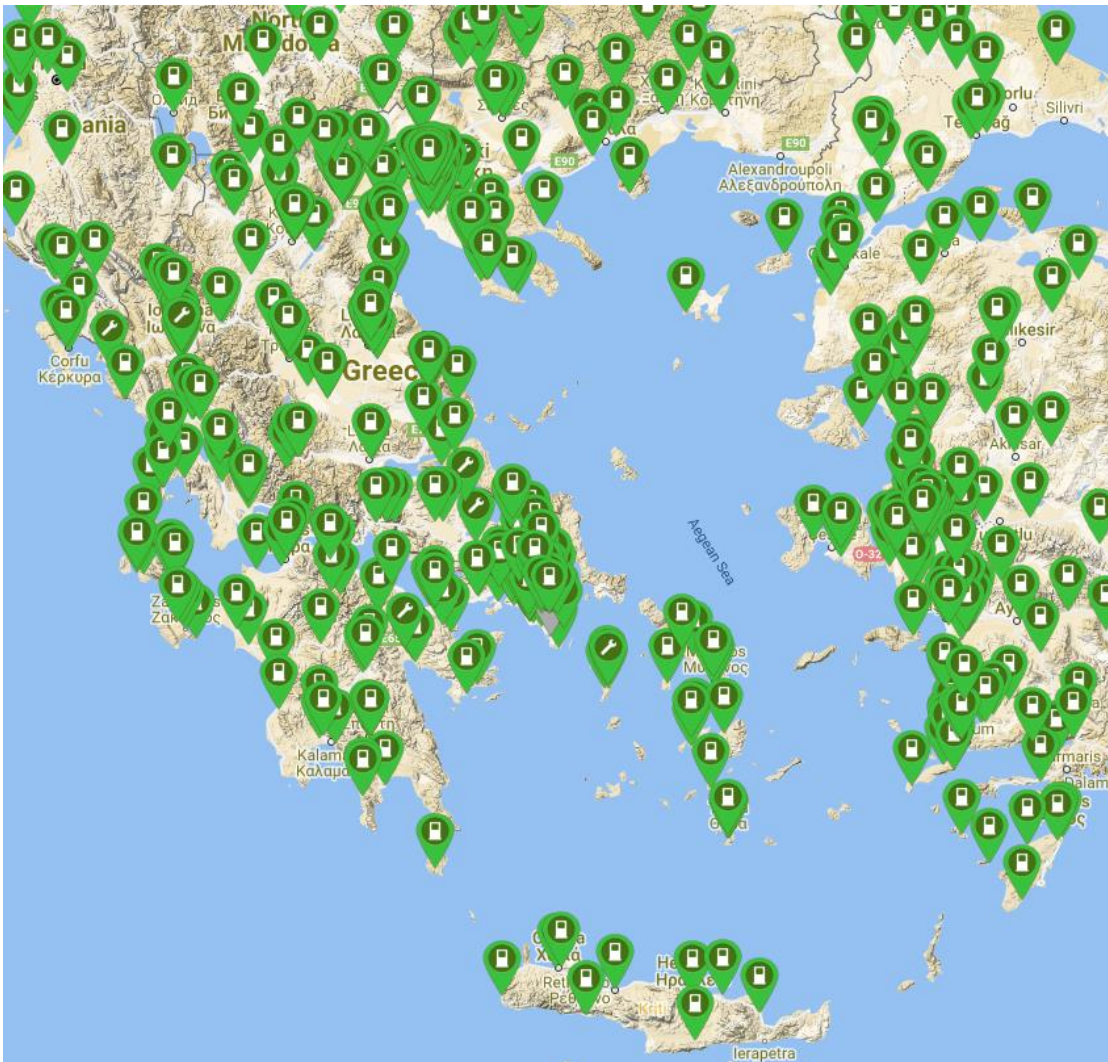


Figure 2: AC charging stations in Greece

From the Figure 2, it is obvious that Greece is better covered with AC charging stations respect to the DC fast charging stations. Although the EV market is not big yet, the current charging infrastructures are not enough to follow the EV market growth rate.

Wallboxes that are also sold in Greece also can be considered as a charging infrastructure and they are promoted by incentives on behalf of the Greek government as well. Almost every EV owner chooses to buy a wallbox in order to increase his charging power and reduce the charging time of his EV in domestic charging. The exact number of wallboxes already sold is unknown but for sure it is not a negligible amount and contributes to the growth of the EV market in Greece.

It is easy to understand that the charging stations' market is a fast growing market that attracts many companies to invest in it year by year. The major companies currently investing on the Greek territory in charging stations are in the following sub-sections.

2.1. Operators in Greece

ElpeFuture

Hellenic petroleum has created ElpeFuture to deal with the EV charging stations. It operates in the South East of Europe. Hellenic petroleum wants to be part of the carbon neutralization, and the e-mobility is an important part of its strategy.

It has become a leading operator for fast charging stations in Greece. It is known as one of the fastest developing players on the Greek market.

Blink network

Blink operates since 2009 and today is one of the world's leaders in providing charging solutions. The company expands its network around Europe by acquiring smaller operators in many countries. In Greece, it operates about 30% of the charging points. The company installs mainly 22kW AC charging stations close to the cities.

DEI Blue

DEI Blue is the biggest Greek operator. The company is controlled by the Public electric power corporation. Together with Blink, they operate around 60% of the market on the Greek territory. Today DEI blue controls/manages more than 300 charging stations. It operates the largest charging point in Greece, which is situated close to the airport of Athens, and it can recharge up to 14 vehicles at the time. This charging point has two DC fast chargers and one ultra-fast. The main goal of DEI Blue is to install 10,000 chargers in Greece by the end 2025.

NRG

The group is a leader in the energy sector in Greece and in the wider Eastern Mediterranean region. It supports the economy with exports to over 45 countries and continuously (continues with) new investments. Its 30 DC charging stations are located on the Shell & AVIN service stations of the motorway. (? only one existing).

Samsung

Samsung has a small part of EV charging infrastructures in the Greek market. It has mainly installed AC charging stations in the cities.

Tesla

Tesla has and operates the world's largest DC fast charging network having more than 30,000 superchargers in 5,000 locations worldwide. The energy in Greece for Tesla chargers is provided mainly by DEI Blue.

2.2. Manufacturers in Greece

MC CHARGERS

MC CHARGERS introduces the first made in Greece electric vehicle charger. The solutions that company offers are ORION 7kW, 11kW & 22kW.

Geyer

Geyer since 2019 invests in Electricity, concluding a strategic agreement with one of the leading German companies, ABL, and supplies Electric Car Charging Stations on the Greek market.

ABB

ABB offers the energy but not the charging points. On the Greek territory it has a strong collaboration with ElpeFuture.

2.3. The case of Macedonia & Thraki

The BEV and PHEV traffic in the northern Greece is relative small and becomes smaller near the borders where the infrastructures are not enough. As said before the number of EVs in the northern Greece is not very high yet but this is something that is going to change in the very near future.

A specific study is indicating the necessary changes that should be made as soon as possible in order to be feasible for every EV owner to cross the borders and arrive to the final destination in a certain country. For this specific purpose there are 5 itineraries that have been studied separately and came out with specific propositions. They are presented in the Section IV.

In the specific region subject of the study, the charging station infrastructures are relatively small, for both, DC and AC. The aim is to engage new hosts (mainly SMEs) located near the borders which to be motivated to install an AC charging stations of up to 22 kW power on their/private territory.

2.4. Business Models from the Greek perspective

In this section there are 3 business model canvases related to the SMEs willing to install a charging station on the territory of their enterprises:

- Hotels
- Restaurants & Coffee Shops
- Super markets

On **Error! Reference source not found.** 3 the Business Model Canvas for the hotels indicates that the revenue could be quite high for the SME if installing a charging station on its territory. It will become more attractive for the tourists using EV and the SME may increase its income from clients using their infrastructure and hotel's facilities during their vacations.

Business Model Canvas				
Designed for: Hotel				
Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
<ul style="list-style-type: none"> Consultants Engineers Municipality Banks 	<ul style="list-style-type: none"> Charging stations e-Mobility services Environmental greening 	<ul style="list-style-type: none"> Ensurness of the autonomy of client's EV (35' of charging to gain 100 km of autonomy) Relaxing while charging the EV in hotel's facilities 	<ul style="list-style-type: none"> Assistance for new users 	<ul style="list-style-type: none"> Whoever crosses the border from Bulgaria to Greece and vice versa Whoever owns an EV and is resident in the around area Hotel's clients Tourits
	Key Resources		Channels	
	<ul style="list-style-type: none"> Charging stations Software e-Roaming Application Platforms 		<ul style="list-style-type: none"> Municipality Website Instagram Local newspapers 	
Cost Structure		Revenue Streams		
<ul style="list-style-type: none"> Charging Station construction Web Marketing Integration in online platforms 		<ul style="list-style-type: none"> Prices equal to the european standards – about 0.60 € per kWh Income from the clients that are using the hotel's facilities while waiting for the charging 		

Figure 3: Business Model Canvas for Hotels

On Figure 4 the Business Model Canvas for the Restaurants and Coffee Shops shows that the expected revenue for the SME installing a charging station on its territory is quite high. The revenue will get higher due to the increase the number of clients with EVs charging their EV while enjoying their meal or coffee break.

Business Model Canvas				
Designed for: Restaurants & Coffee Shops				
Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
<ul style="list-style-type: none"> Consultants Engineers Municipality Banks 	<ul style="list-style-type: none"> Charging stations e-Mobility services Environmental greening 	<ul style="list-style-type: none"> Ensurness of the autonomy of client's EV (35' of charging to gain 100 km of autonomy) Take a break from your travel getting a snack or lunch/dinner 	<ul style="list-style-type: none"> Assistance for new users 	<ul style="list-style-type: none"> Whoever crosses the border from Bulgaria to Greece and vice versa Whoever owns an EV and is resident in the around area Tourits Restaurant's clients
	Key Resources		Channels	
	<ul style="list-style-type: none"> Charging stations Software e-Roaming Application Platforms 		<ul style="list-style-type: none"> Municipality Website Instagram Local newspapers 	
Cost Structure		Revenue Streams		
<ul style="list-style-type: none"> Charging Station construction Web Marketing Integration in online platforms 		<ul style="list-style-type: none"> Prices equal to the european standards – about 0.60 € per kWh Income from EV owners that taking a break from their travel to take a snack on the restaurant/ coffee 		

Figure 4: Business Model Canvas for Restaurants & Coffee shops

On Figure 5 the Business Model Canvas for Super Markets shows that if the SME installs a charging station on its territory may expect higher income in respect to the traditional one. The revenue would get higher because many clients who are also EV drivers/owners will choose this Super Market and have two tasks completed in the same time – shopping and EV charging.

Business Model Canvas				
<i>Designed for:</i> Super Market				
Key Partners <ul style="list-style-type: none"> • Consultants • Engineers • Municipality • Banks 	Key Activities <ul style="list-style-type: none"> • Charging stations • e-Mobility services • Environmental greening 	Value Propositions <ul style="list-style-type: none"> • Ensurance of the autonomy of client's EV (35' of charging to gain 100 km of autonomy) • Buying goods while charging the EV 	Customer Relationships <ul style="list-style-type: none"> • Assistance for new users 	Customer Segments <ul style="list-style-type: none"> • Whoever crosses the border from Bulgaria to Greece and vice versa • Whoever owns an EV and is resident in the around area • Tourists • Super markets's clients
	Key Resources <ul style="list-style-type: none"> • Charging stations • Software • e-Roaming • Application Platforms 		Channels <ul style="list-style-type: none"> • Municipality • Website • Instagram • Local newspapers 	
Cost Structure <ul style="list-style-type: none"> • Charging Station construction • Web Marketing • Integration in online platforms 			Revenue Streams <ul style="list-style-type: none"> • Prices equal to the european standards – about 0.60 € per kWh • Income from EV owners that are shopping from the supermarket 	

Figure 5: Business Model Canvas for Super Markets

As a conclusion of all Business Models, it can be said that since the EV market is getting bigger with geometric progression, the SMEs choosing to invest now on a charging station installment can expect much higher revenue in the near future. The need of energy for mobility is getting higher and higher as the EV market grows. In the next few years the charging stations will be located/installed everywhere and the first investors would be a step ahead in respect to the other competitors by acquiring the know-how as early as possible.

III. E-MOBILITY IN BULGARIA

In 2011, the concept of an electric car was still not well known, despite occasional expressions of enthusiasm from some people.

At the end of 2021, there were around 3 000 000 registered vehicles in Bulgaria. The number of electric cars was around 3,500 which is less than 1% of the total amount of cars in the country⁴. If

⁴ Investor.bg [<https://www.investor.bg/novini/444/a/nacionalniat-avtopark-se-sviva-s-blizo-50-hil-avtomobila-prez-pyvoto-polugodie-332505/>]

we compare the sales between 2020 and 2021 we can see that there is a 14% increase for the first three months and 70% for the second three months⁵.

Today there are around 6,000 Battery Electric Vehicles (BEV), a further 70% increase, and over 600 charging stations. The market is growing in line with the World market despite the lack of vehicle subsidies.

The main factor for the slow spread of electric cars is the poorly developed charging infrastructure.

The Bulgarian government strategy involves the installation of 10.000 stations till 2025. 10% of them are expected to be fast chargers and mostly operated by private companies. The remaining part will be mostly municipal charging stations.

What still hinders activities in this area is the lack of a clearly defined and effective state policy, the lack of rules, the lack of various incentives and reliefs for companies building charging infrastructure as well as, albeit a small example, for purchased electric cars for fleets of the administrative structures in Bulgaria. The fact is that the lack of support teams is still something that makes it very difficult for both operators and users.

Despite everything described above, there was some movement in 2021 with the inclusion of new networks and more specifically with the installation of Hypercharger stations in the Fines Charging network.

The trend picked up in 2022 and in the last few months the number of charging stations installed by operators has continued to increase. As administrators of the official map for charging stations in Bulgaria - "VsichkoTok" - new locations on the map and new people and companies that are involved in the construction of the charging infrastructure are marked almost every day.

Table 5: Locations and Station units per operator in Bulgaria.

Operator	Locations	Stations	Operator	Locations	Stations
Fines Charging	64	80	Varna Charging	22	22
ElDrive	151	268	Gigacharger	12	15
eCars/VsichkoTok	60	66	Travel By Electric	4	4
AutoBOX/VoltSpot	41	49	Wink Charging	6	6
KIA Hypercharge/ELBUL	26	27	GPStation	7	7
EVPoint	31	60	Bullcharge	4	17
Pro Credit Bank	48	60	EVN	5	5

⁵ National Automobile Manufacturers Association the official web site.

Kaufland	13	13			
Total: 494 locations / 699 stations					

By the end of 2022 in Bulgaria there are already 15 networks with charging stations, and some of them started with first locations and their own mobile application. (Bullcharge and Wink Charging).

As of July 2022, according to data from the www.ecars.bg team, the number of publicly accessible charging stations is slightly over 800. It is difficult to provide an absolutely accurate number without regulation and rules, according to which the submission of information about each newly installed charging station to a given authority and a given location. Teams carry out this activity and collect, verify and publish constantly updated data on the charging infrastructure.

Bulgaria turns out to be among the champions in terms of the number of charging stations against the background of electric cars on the roads, according to the new report of the European Association of Automobile Manufacturers (ACEA). Data for Bulgaria show that the number of charging stations in our country is growing. Bulgaria ranks 16th in the European Union (EU) when it comes to the ratio of the market share of electric cars to the total sales of new cars and the number of charging stations per 100 km. If in September 2021 there are 0.8 stations per 100 km in our country, then by October 2022 this value will increase to 2.3 stations per 100 km.

We are currently in the middle of the chart in Europe with an average of 2-3 charging stations every 100 km. The increase in recent months is an average of one charging station per 100 km of roads. Most electric cars on the market currently travel on average about 150 km with one battery charge, which at a charging station with a capacity of up to 22 kW takes from 1 to 6 hours, depending on the make and model of the electric car. From 2022 a new generation of mass electric cars with double the range has been launched.

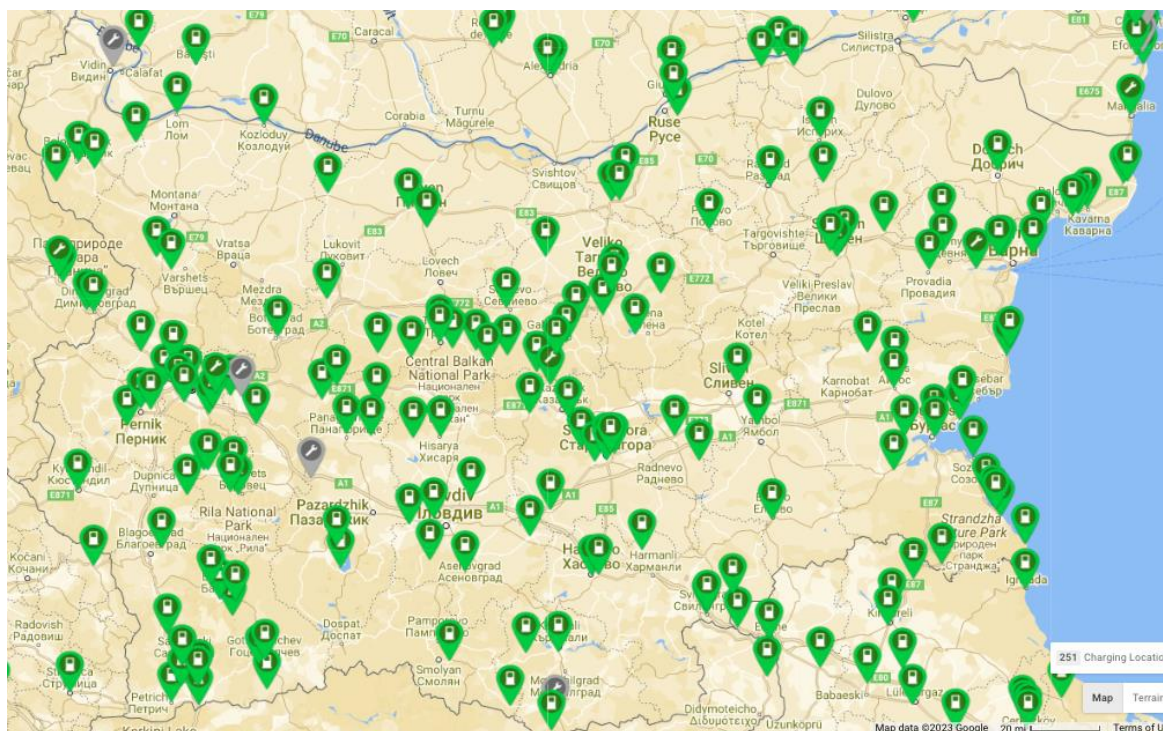


Figure 6: AC charging stations in Bulgaria (Source: PlugShare)

At the moment, there are enough stations in Bulgaria, because compared to most European countries, especially the more developed ones, the availability of electric cars is still much less.

Occupying the fifth place in the EU, Bulgaria overtakes the richest countries in the Community, where electric mobility is also the most developed. For example, in Germany 16.4% of charging stations for fast. During the international forum "The Green Transition - Solutions and Challenges for Bulgaria", organized by Dir.bg and 3eNews it was emphasized how in many ways our country is ahead of Germany in the development of electric mobility although in our country there are almost no subsidies for purchase of electric cars. Out of 3,000 such, only 30 were bought through a support scheme, while in Germany they are mostly bought with subsidies.

Another example was given showing that the Germans have one charging station for every 10 electric cars, while the Bulgarians have only 6 electric cars "fighting" to charge at one station. And following the ACEA information it becomes clear that Bulgaria is also ahead of Germany in terms of the share of fast charging stations, which are increasingly being talked about and which are expected to solve the problem of electric car trips over long distances, where there will be a need of recharging the battery along the way.

It turns out that in this respect we are ahead not only of Germany, but also of more than 20 EU countries. In France, the share of fast chargers is only 8%. And in the distribution leader the Netherlands, where by the end of 2020 a total of 66,665 chargers for electric cars were installed, the fast ones are a paltry 3.6%, although the number is by no means negligible - 2,429.

If comparing with the neighboring Member States, Bulgaria also shows better results in terms of the share of fast charging stations. Although after Bulgaria, in Romania it is not much smaller - 35.7%. But compared to the much richer Greece, both countries are significantly ahead, since in our southern neighbors only 8 percent of the charging stations are fast, which are few and in number - only 22. It is true that as our northern and southern neighbors have more chargers - 493 and 275, respectively. But in Romania, the population is 3 times larger than in Bulgaria, and in Greece - 1.5 times. Seen from this angle, it appears that the Bulgarians have more chargers for electric cars than both the Romanians and the Greeks, per capita.

Another interesting point in the ACEA analysis is that Eastern European countries are definitely ahead of Western countries in the development of fast charging infrastructure. The only exceptions are Spain with a 28.7% share of fast charging stations, Ireland with 25.7%, Portugal with 20% and somewhat Denmark and Austria with their shares of 17.1% and 16.7% respectively.

It is also a curious fact that rich Luxembourg is at the bottom of the ranking, where out of a total of 1,061 charging stations, only 10 are fast, which represents a share of only 0.9%.

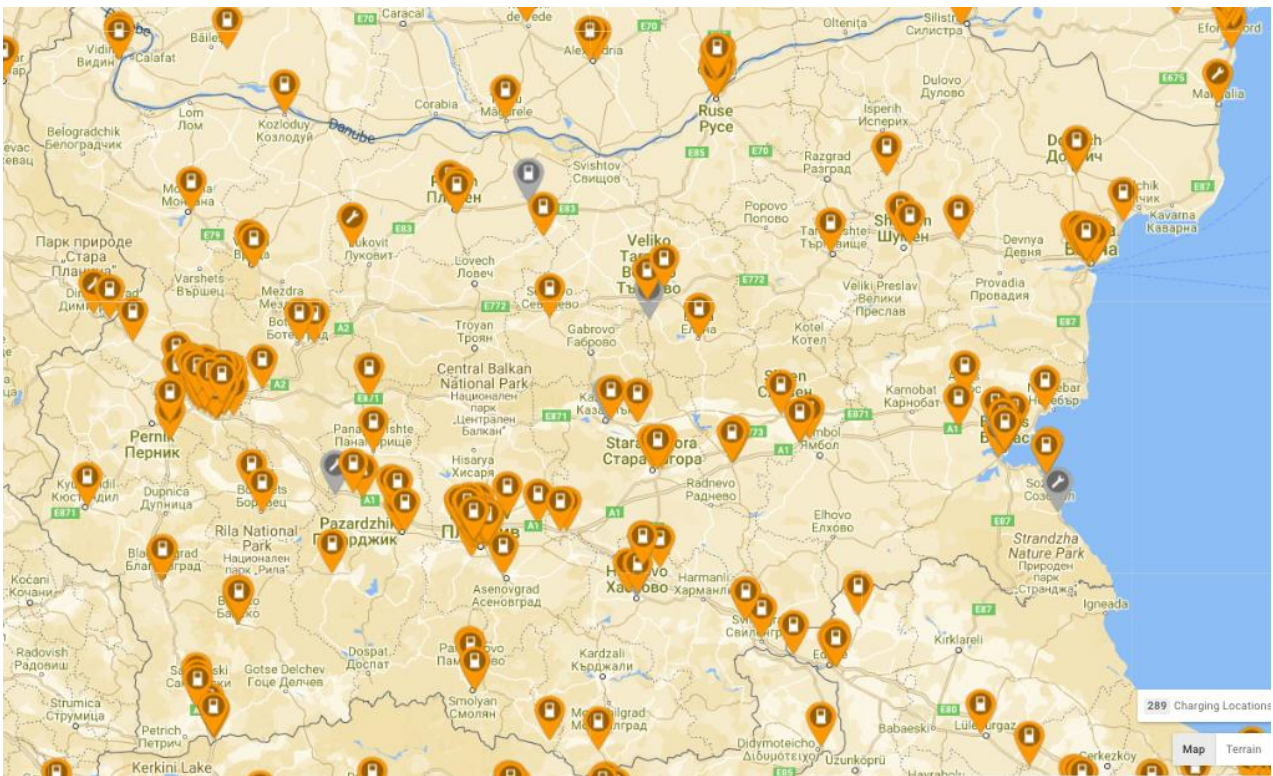


Figure 7: DC fast charging stations in Bulgaria (source: PlugShare)

According to ACEA, the research shows the existence of two problems with the development of charging infrastructure for electric vehicles in the EU. On the one hand, there is not only a clear lack of sufficient chargers in the Community in relation to policy requests for a progressive increase in electric vehicles, but very few chargers can actually charge vehicles at an acceptable rate.

3.1. Operators in Bulgaria

The main Charging Point Operators (CPOs) are as follows:

ELDRIVE

ELDRIVE is the biggest operator on the Bulgarian market. The company was founded in 2015 and operates today around 500 charging points in Bulgaria and Romania. ELDRIVE is expanding its network via different partnerships with other businesses. They have signed a partnership with Shell and OMV – leading gas stations owners.

Eldrive's goal is to help maintain a sustainable environment by making charging electric vehicles easy and making electric mobility a part of people's everyday lives.

In the Eldrive application, owners and users of electric cars can find information about the location of charging stations from the network, be directed to them, and check whether the station they have chosen is free or occupied in real time. Through Eldrive's smart platform, users can charge their electric car easily and conveniently and pay directly through the app.

Eldrive also entered into a partnership with ProCredit Bank to support electromobility in our country. As a result of the signed partnership, and in continuation of the initiative to stimulate environmentally friendly mobility, accessibility to electric car owners is ensured with 20 more charging stations in the Eldrive network.

The charging stations from the first stage of the partnership between Eldrive and ProCredit Bank are located at key locations in Sofia (10 charging points), Plovdiv (6 charging points), Varna and Burgas (two charging points in each city).

FINES

FINES charging is one of the fastest developing operators in Bulgaria. The company is operating more than 60 charging points. At the moment they are in process of installing 18 more stations. The goal of FINES is to be the fastest charging network in Bulgaria and they operate mostly DC stations.

VOLTSPOT

VOLTSPOT develops and manufactures innovative charging solutions for electric vehicles. In the last years they developed a considerable network and today they are one of the leading operators in the country with over 50 charging points.

They manufacture AC and DC stations. Their prices start at 1,500 euros for an AC station without the installation costs and 10,000 euros for a DC station.

eCars

Ecars develops charging stations according to private demands. They elaborate the design following the needs of their partners, which are mainly small businesses who are willing to attract more customers that use electric vehicles. They aim to make the e-mobility accessible to everyone. Today eCars is operating around 70 stations.

ELBUL & KIA

ELBUL are mainly concentrated in charging solutions for small business. Together with KIA they are the Virta network partners in Bulgaria and operate close to 50 charging points.

EVPOINT

EVPOINT was created in the year 2018 and wants to promote the importance of e-mobility. They are distributing various types of charging stations and software solutions. The company has installed around 30 public stations around the whole country.

EVN

EVN is one of the leading power operators in Bulgaria. In 2020 the company decided to enter in the sphere of e-mobility. Today EVN operates 5 stations in three cities in Bulgaria.

GP STATION

GPSTATION is a new operator who wants to facilitate the access to charging solutions for the users of electric vehicles. This company does not agree with the model of closed network and the need of an application for every different operator. For this reason, they privilege the possibility for payment by credit card at their stations.

Travel by Electric

A good example of combining the activities of charging station operators, manufacturers of electric cars and other types of business, for example in tourism, is the activity of the tourist company Travel by Electric –, which provides electric cars for rent ("Rent an electric car adventure") for various touristic destinations, visits and events in Bulgaria and provides/uses for charging both its own installed charging stations and in partnership with many Bulgarian operators.

3.2. Manufacturers in Bulgaria

Elprom EMZ

Located in Shabla, near Varna, Elprom EMZ is the Bulgarian manufacturer that stands out with the successful deployment of over 500 charging stations in different European countries, 100 of which in Bulgaria for some of the above operators.

"Electromobili BG"

The sale of charging stations and infrastructure for electric cars with fully Bulgarian development and production also begins, according to the announcement of the manufacturer "Electromobili BG". The company plans to build a network that will make it easier for users to charge their cars near preferred restaurants, hotels, gas stations, sports and other facilities. In parallel with the sale of charging stations, the company has developed an online locator and a mobile application with charging locations - VsichkoTok.bg. In addition, the company plans to invest in networks of fast charging stations with partners such as gas station operators and highway retail outlets.

3.3. Business Models from the Bulgarian perspective

Currently there are three main business models which an site owner can analyze. They have their own pros and cons, can differentiate per location and choosing the correct model depends highly on the desire input and outcome.

- **Full ownership of the station**

The site owner is the main investor in infrastructure, hardware and site works. This can provide a higher outcome for the site owner as a % of generated sales. Such investment will require only software, marketing and billing services from the operator for which each operator can offer a fixed monthly cost/ % of income model or mixed variants. The costs for the operating services which can be expected are currently near to 15 eur/month/station or approx. 10% of operating revenue.

- **Partial ownership of the station**

The site owner and the CPO can decide to split the investment as per negotiation and contract. This will require a higher amount of cooperation from both sides and can result in different outcomes depending of the desires of each party. The proposed business model is not easily achievable as it includes a lot of time and effort from both parties and negotiations can prolong the process.

- **Location providing**

The site owner provides the location for the placement of the station and his sole obligation is to maintain the area and provide the needed legislative agreements for the placement of the station. The investment in infrastructure, hardware, software and operative services are all undertaken by the CPO. For providing the location, the site owner is entitled to a %of gross revenue or net operative revenue depending on the initial agreement. This business model can provide the site owner with another revenue stream without any investments and can also attract new customers and add to the public image of the location.

Types according to the site owners

The partnership business model: This is the most common business model. The operator is looking for capable partners ready to contribute to the development of the e-mobility by providing space for the installation of charging stations. A good example of this business model is the partnership between Shell, OMV and ELDRIVE. ELDRIVE is rapidly developing its network by using

gas/petrol stations of the multinational companies. In this way the gas station operators attract and other customers to use their stores while charging their cars. Similar kind of partnership can be seen with stations operated by VOLTSPOT. Many of them are located on the territories of a popular supermarket chain – CBA.

Providing stations for small businesses: Almost every operator provides services to small businesses subject to certain conditions such as the accessibility of the station and strategic location of the venue. Ecars is also looking for such business owners. They have installed a large number of their stations in parking lots of various hotels in Bulgaria. It is beneficial for businesses looking for new type of customers.

Operators controlled by energy companies: Many energy utilities (public or private) have decided to enter the vehicle charging business. The Greek DEI created a private organization that manages a large network in Greece. In Bulgaria EVN launched its own network which is still relatively small compared to the leaders in the country.

Municipal engagement: About 20 municipalities in Bulgaria have installed at least one charger that offers free charging. Varna municipality has built a network of about 35 charging stations throughout the city. Charging is done through a special mobile application. Bourgas and the other larger municipalities also plan to install chargers and provide charging services in a similar way.

Retail chains: Kaufland and Lidl have chosen to attract customers through free DC charging and have installed chargers in over 30 of their hypermarkets. Kaufland Bulgaria introduces a paid top-up mode for its customers. The measure entered into force on September 12, 2022. and covers all 13 charging points located in hypermarket parking lots across the country. The price per kilowatt hour for all types of charge is among the lowest in the country - 88 cents per kilowatt. In this way, the main social purpose of the stations is reserved - to support electromobility in Bulgaria. Payment for the service will be made through the VsichkoTok mobile application. The introduction of a charging fee for electric cars comes in response to the growing interest in hypermarket charging stations. Kaufland Bulgaria, as the largest retailer on the Bulgarian market, started equipping its sites with charging stations for electric cars as early as February 2017. The energy provided through them is 100% "green", with which Kaufland Bulgaria strengthens its leading role as a socially responsible company.

3.4. Cost structure of business operators and way of pricing services

When it comes to installing an EV charging station, there are many factors that affect the amount needed to start a business. These are, for example, where the business will start, the

size of the electric charging station business, the number of ancillary services that could be added to the business for the convenience of the customer, and of course, the state of the economy at the time of the start-up business.

Below are the main/key areas where seed capital could be spent:

- General business registration fee;
- Legal costs for obtaining licenses (business license) and permits (e.g. permit from the fire department, etc.);
- Promotion/marketing costs;
- Price for hiring a business consultant, if needed;
- Insurance (general liability, theft, property damage, etc.);
- Expenses for accounting software, etc.;
- Costs for renting/purchasing a location/land/facility for installing a charging station for electric cars;
- Costs for reconstruction of the facility/site, if necessary;
- Other start-up costs (for telephone and utility bills (gas, sewage, water and electricity);
- Operating expenses for the first 2-3 months (employee salaries, bill payments, etc.), if they will be hired.

Some EVC stations now have vulcanization services, car washes, convenience stores, cafes, food outlets and a cigar lounge in their facilities to take advantage of the opportunities around them to generate more revenue.

Therefore, costs for additional services could be added to these costs, e.g.

- EVC machinery and equipment costs (car repair tools, vulcanizing tools and wheel alignment tools, car wash, etc.);
- Website costs;
- Costs for various accessories

Tariffs and return on investment

By joining a charging station operator, the investor receives a standard price tariff based on optimal market conditions, customer solvency and electricity prices to ensure maximum return on investment and development of electric motoring in the country. Due to the dynamic economic situation, the use of a proposed tariff by an operator is the safest method of revenue management due to the monthly cost analysis related to the operation of the charging point. The remote control of multiple charging points by an operator eliminates the need for micro-management of each station. Actual data show that at current costs and revenues related to the management of a charging point on the territory of the republic of Bulgaria, the point of economic equilibrium can

be reached in the first year at 10% occupancy of an AC charging station. These data are encouraging for many investors given the expected growth of the share of EVs in the active fleet in the country. Due to the specifics of different sites, other methods of revenue generation can be used such as tariff for temporary stay, facility usage fee and others.

The global electric vehicle charger market was expected to grow from 1 million units in 2014 to over 12.7 million units in 2021, with charging station deployment subject to a highly variable price range.

At the current stage, level 2 charging stations are sufficiently technologically and software developed. Their price fluctuates, according to experts, between 2000 and 7000 US dollars. Economic analyzes show that in order to achieve profitability or a viable business, the markup of electricity delivered through such level 2 stations should be around 50% - 70%, depending on the degree of use (how many hours a day and how many days a year will use), according to the price of the station, installation costs and others.

There are level 2 and 3 charging stations which, in addition to central power supply, also could install solar collectors and/or wind generators and buffer storage batteries. These additional sources of electrical energy are in a different proportion to the consumption of electrical energy from the central electrical supply for each particular site. In this way, the energy autonomy of the charging stations is ensured up to a certain level of consumption. This practice for the design and construction of energy-autonomous charging stations is emerging as the most promising.

The price difference from a simple home wall box to a DC charging station can exceed 10 times. This does not include installation costs, which could add up to BGN 25,000 for a DC charging station, depending on location and availability.

The major breakthrough in the global electric vehicle charging industry is the result of the increase in the number of electric vehicle owners, which is due to the campaign to save the ecosystem.

In an effort to stay afloat in the fast-growing EV charging business, EVC station owners are now doing their best to make their facilities welcoming and convenient for customers.

3.5. Mapping of power stations in Bulgaria

Mobile applications have been developed in Bulgaria to help users. One of the applications is on ecars.bg. In Bulgaria, the VsichkoTok mobile application is also gaining popularity.

Thanks to the web page collecting in one place the locations of charging stations for electric cars (100% electric and PHEV chargeable hybrids) on the territory of Bulgaria, we understand that at the end of 2022. their number has exceeded the limit of 900 units.

At the moment, the website vsichkotok.bg has data on a total of 912 charging stations located on the territory of 680 locations. 184 of them offer DC fast charging option and the remaining 495 for AC charging.

The largest "cluster" of fast (CCS) charging stations - 54, is in Sofia and within a radius of 10 kilometers from the ring road. In Plovdiv and the surrounding suburbs there are 20, and for Burgas the map shows 10 points.

The total number of CCS charging points in Bulgaria is 200, and that of the CHAdeMo standard is 91.

There are still not enough charging stations for electric cars on the roads in Bulgaria. The problem is not the roads themselves.

Bulgaria lags behind in the construction of charging infrastructure for electric cars on the main road network. Currently, our country ranks 16th among the 27 member countries of the European Union

And although Bulgaria is not among the five worst performers in the ranking, our country should catch up in order to respond to the growing demand for electric cars and the condition of the European Union, according to which by 2025 charging stations should be deployed every 60 km on major roads.

In the last few months, ACEA's statistics show that only in Bulgaria there is a growth in the purchase of electric cars.

Unfortunately, the procedures for installing charging stations in Bulgaria, especially at sites such as gas stations or parking lots, is quite difficult and complicated, which takes a lot of time and money.

Description of the road structure in Bulgaria, in particular the eligible areas of Blagoevgrad, Smolyan, Kardjali and Haskovo

On the territory of the regions (within the scope of the project), enough first, second and third class roads of the republican network have been built, which are also of interest to investors/operators. These roads were visited by the project in order to identify small and medium-sized enterprises that would express an interest in installing charging stations. The problem is that these districts are in mountainous regions (Rhodopi - for Smolyan and Kardjali districts, Sakar - for Haskovo district, Rila and Pirin - mainly for Blagoevgrad district), where the

main population is agricultural producers, business is very poorly developed, in many places even lack one. This also determines the lack of declared interest.

Capacity of electricity distribution companies, in particular the eligible areas of Blagoevgrad, Smolyan, Kardjali and Haskovo

In general, the electricity distribution companies have capacity, but in these areas the infrastructure is not sufficiently developed. Even if an interest is expressed, the lack of power leads to a delay in the installation process, since expanding the network or increasing its capacity in places requires that these investments and costs be included in the investment plans of the respective electricity distribution company, which may take years.

Apart from that, the very process of examining the investor's application and subsequently issuing a permit to install a station and commit capacity is a very cumbersome procedure that takes a lot of time and represents a serious expense for the investor.

A serious problem is that even in locations where infrastructure is in place, there are frequent power outages and/or loss of internet connection, which further creates difficulties that cannot always be resolved remotely and often take far longer than expected until a given charging station is back in service and in normal operating mode.

Practices to stimulate the transition to e-mobility (including subsidizing the activity)

According to forecast data, in the next 2-3 years the number of electric cars is expected to reach 10% of the annual production in the world - 6 million electric cars. It is expected not only to increase the restrictions on the use of LPG cars in the big cities, but also to ban the production and sale of new ones in the next 10-15 years. The main factor is the low energy efficiency of LPG - for 100 km of mileage, an LPG car consumes 66 kWh at a consumption of 6 l/100 km, and at a consumption of 12 l for a jeep, the energy consumption is 132 kWh. An electric car needs 15 kWh per 100 km (this 15 kWh does not include the energy consumption for the production of electricity from the power plant).

At the current stage, the initial price of an electric car is 30% to 50% higher than the price of a diesel car of the same body type, which is a serious deterrent to its mass demand. Added to this fact are the unknowns at this stage of the operation of electric vehicles and the lack of a developed charging infrastructure. In order to encourage the purchase of electric cars, various financial and tax incentives as well as non-monetary privileges for electric car users are offered in many countries in Europe and worldwide.

In some countries, grants are provided for the availability of charging stations for electric vehicles in the workplace. Company owners can choose whether to provide the service for free or for a fee, but many prefer the free option to encourage the use of electric vehicles within the company and among customers and visitors.

For Bulgaria at the current stage, the introduction of electric vehicles is a free territory. Added to the above reasons is the lack of sufficient awareness among the population, as well as the lack of companies that offer electric cars. With a well-organized explanatory campaign, accompanied by a real presence on the roads of pilot electric cars, engaging companies with the supply of new and companies for the conversion of LPG cars into electric cars, offering financial instruments for leasing a battery and/or the entire electric car, as well as local or national incentives for electric car users, the number of the electric cars for the country can be expected to grow.

3.6. Demand Forecasting for EV Charging (Needs Analysis)

The added value of EU action is that alternative fuel infrastructure is a transnational challenge. However, individual member states currently do not have the necessary tools for pan-European coordination. What the EC can do is to adopt common standards to ensure interoperability, coordinate and help member states build electric charging infrastructure, and monitor progress. In addition, through the Connecting Europe Facility (CEF), it provides financial support for electric charging infrastructure.

However, the pace of installation of charging infrastructure remains a problem in Europe. While the share of electric vehicles is growing rapidly, the availability of charging stations in many EU member states remains limited.

Not only is there a shortage of electric vehicle charging stations on major EU roads, but the majority of these devices do not provide fast charging, according to a study by ACEA.

Charging speed is also a major issue across the continent, as fast chargers (with a capacity of over 22 kilowatts) represent a small fraction of the total number of stations. In fact, only one in seven of all charging stations in the EU offer fast charging. All others have a capacity of 22 kilowatts or less without offering an acceptable charging speed.

Most electric vehicle drivers charge their cars at home, so many public charging stations remain underutilized. At the same time, many people who still drive gasoline-powered cars don't decide to go electric until they see more widespread deployment of charging infrastructure, for fear of running out of power while on the move.

EV drivers use public charging stations too rarely, with most cars already offering a relatively long range on a single battery charge of 80%, which further cuts down on the number of recharges.

Electric vehicle charging infrastructure — despite increasing numbers, uneven distribution of charging stations makes traveling in the EU difficult

The European Court of Auditors (ECA) has carried out an audit to determine the effectiveness of the Commission's support for the deployment of publicly available charging infrastructure for electric vehicles in the EU.

The ECA found that despite successes, such as promoting a common EU standard for plugs and improving access to different charging networks, barriers to electric vehicle travel still exist in the EU. The availability of charging stations varies from country to country, payment systems are not harmonized with minimum requirements and there is a lack of appropriate information for consumers. As no comprehensive analysis of the infrastructure gap has been carried out, the Commission cannot ensure that EU funding goes where it is most needed. The EU is still far from reaching the Green Deal target of one million charging stations by 2025 and lacks a comprehensive strategic roadmap for electromobility.

The deployment of charging infrastructure alongside the use of electric vehicles is a key factor in the transition to alternative fuels and an almost entirely zero-emission car fleet by 2050. The ultimate goal of the policy is to make charging electric vehicles as easy as possible, as much as filling a traditional tank so they can travel across the EU without difficulty.

In order to achieve this goal, the EU is faced with solving the following two-pronged problem — on the one hand, vehicle entry will be limited to the provision of charging infrastructure, while on the other hand infrastructure investment requires greater security in terms of the rate of vehicle penetration.

With its efforts, the EC is contributing to consumers gradually gaining more harmonized access to different charging networks. However, barriers to electric vehicle travel continue to exist within the EU. Although the charging network in the EU is growing, the deployment of stations is uneven, as there are no clear and consistent minimum infrastructure requirements to ensure electromobility across the EU. The EU is still far from its ambitious Green Deal target of one million charging stations by 2025 and lacks a comprehensive strategic roadmap for electromobility. Traveling in the EU is further complicated by the lack of harmonized payment systems with minimum requirements and adequate information for consumers about the real-time availability of charging stations and billing.

Charging infrastructure

One of the main factors holding back the wider adoption of electric vehicles is the perception that they cannot cover the desired distance without needing to be charged. This could be due to either an actual lack of charging infrastructure or a lack of awareness that it exists. Although the network of charging stations is growing at different rates across the EU, like the use of electric cars, it is still

insufficient in some countries, while centralized information on all existing charging points is also missing.

Most public charging stations in the EU are located in the urban areas of countries such as the Netherlands, Germany and France. In 2017, for example, in the Netherlands there were over 32,000 charging points and more than 119,000 registered electric vehicles, while in Greece the numbers were 40 and just over 300, respectively. every 60 km.

The cost of a DC station is significantly higher than that of an AC one, but this is offset by the fact that charging takes place much faster. Most DC charging stations today offer a power of 50 kW, but lower levels of around 20-25 kW are also available. A transition to levels of 100-150 kW, even up to 400 kW is currently being seen to serve the next generation of EVs with much higher capacity batteries (80 kWh and above).

The goal of DC charging stations is to provide up to 80% of an EV's charge in 20 minutes or less. Experts believe that levels above 150 kW, at least in the short and medium term, will only be applicable to a very small segment. Such capacities represent a technological challenge for the battery, so the availability of station models that charge to such levels will remain limited.

Electric cars have different charging needs, so it is important to install a charging point that will be compatible with the maximum number of electric cars. The most common are the 7kW Type 2 wall-mount chargers, which are compatible with most of the best-selling electric vehicles and can fully charge a battery in around 3-7 hours depending on the model.

IV. SPECIFIC AREAS OF STUDY (BULGARIA-GREECE CROSSBORDER)

Itinerary - Petrich and Sandanski to Serres/Sidirokastro

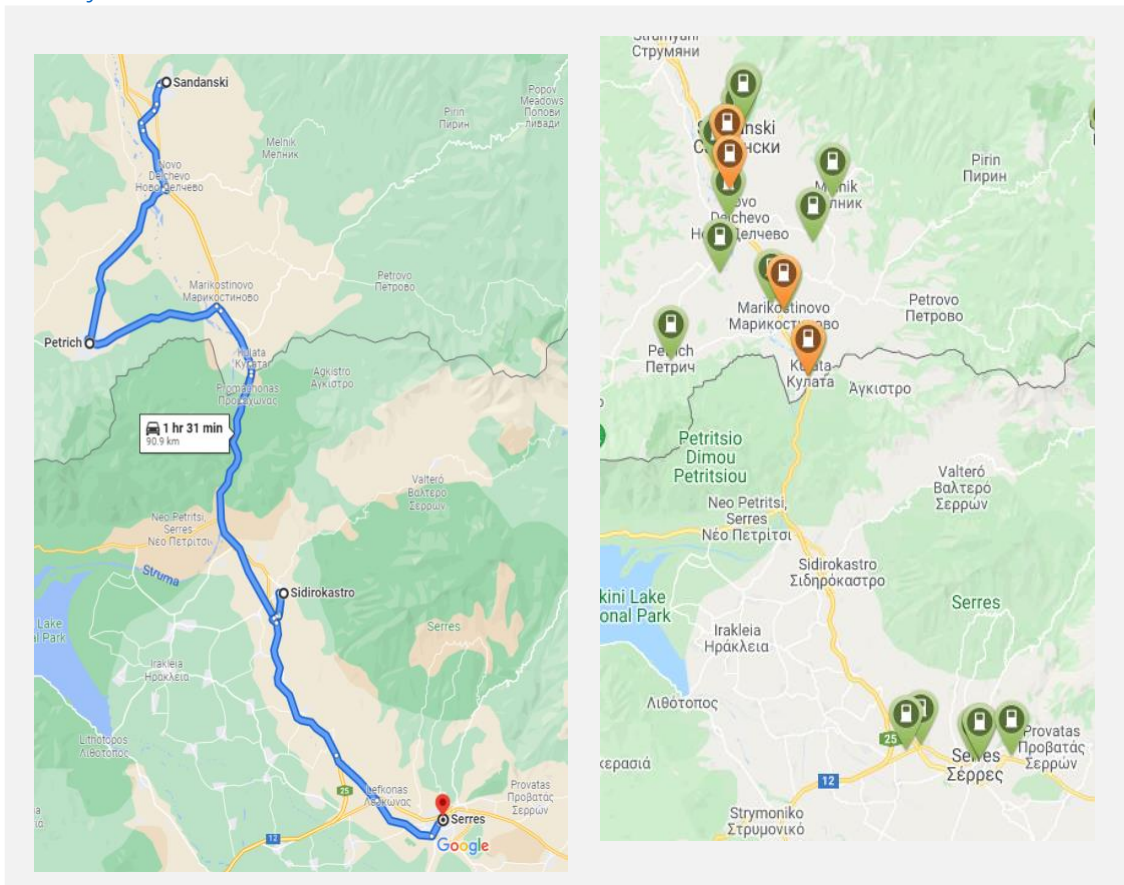


Figure 8: Itinerary - Petrich and Sandanski to Serres/Sidirokastro

There are at least 19 charging stations in the specific itinerary:

- 4 DC fast charging stations: 2 at Sandanski: CHAdeMO DCFC, CCS DCFC, cost: 0.50 €/ kWh; 1 at Marikostinovo CHAdeMO DCFC, CCS DCFC, cost: 0.45 €/ kWh; 1 at Kulata CHAdeMO DCFC, CCS, cost: 0.65 €/ kWh
- 15 AC charging stations

The main problem in this itinerary is that there are 45 km, from Kulata to Serres, without a charging station. The current traffic flow according to Promaxons border guard's estimation is around 50 BEV or PHEV per year in both directions. In order to meet the forthcoming needs, it will be required in addition one or two charging stations in the city of Sidirokastro or nearby and another two in Serres.

SMEs that indicatively can be targeted/advised:

- Stathmos café: Close to Promaxonas → [Location](#)
- Tsintsaris supermarket: Close to Sidirokastro, on the national road → [Location](#)
- Masoutis supermarket: Between Sidirokastro and Promaxonas → [Location](#)
- Acropolis Hotel: Between Serres and Sidirokastro → [Location](#)

Itinerary - [Gotse Delchev](#) to Drama and [Kavala](#)

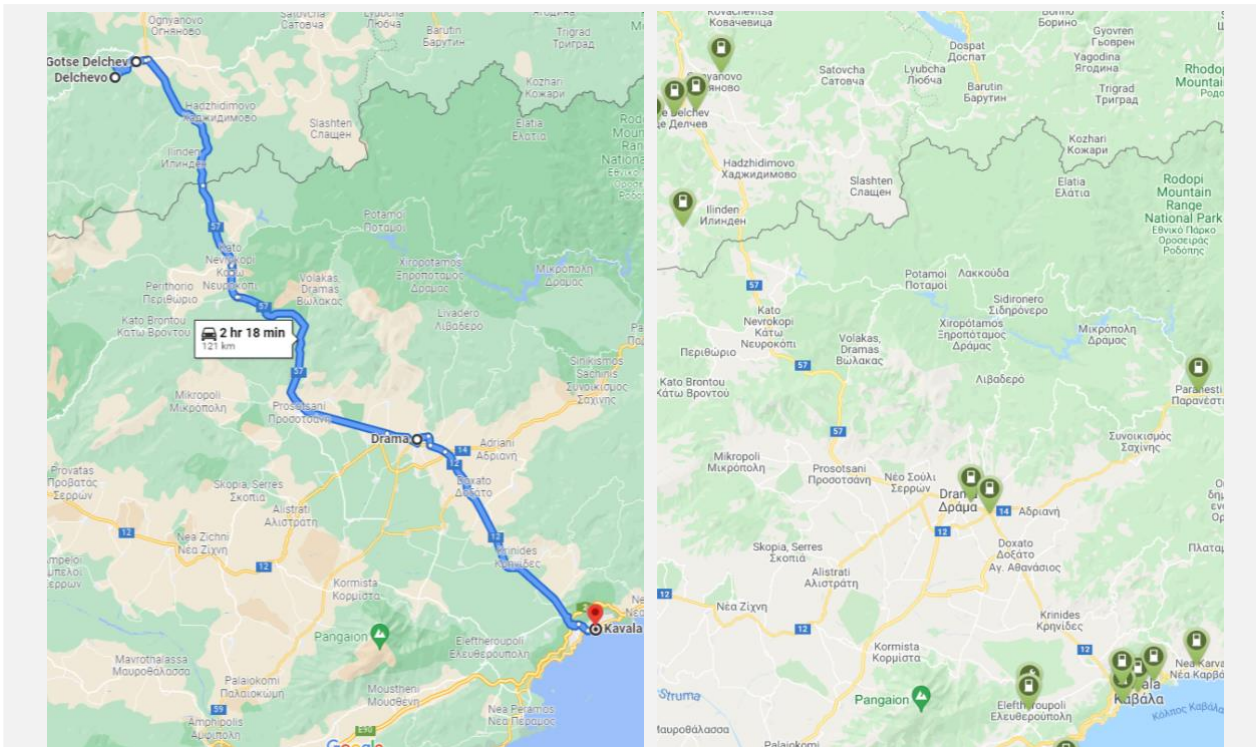


Figure 9: Itinerary - Gotse Delchev to Drama and Kavala

There are 16 charging stations in the specific itinerary:

- 0 DC fast charging stations
- 16 AC charging stations

In this itinerary there is a major problem, due to the distance of 121 km between Gotse Delchev to Drama/ Kavala without DC fast charging station. There is only a couple of AC charging stations in Drama that can mitigate the problem but not to solve it.

The traffic flow in this itinerary is 2-5 BEV or PHEV per month in both directions according to the local police estimation (Nevrokopi). In order this specific itinerary to be well covered it will request two or three charging stations in Gotse Delchev, three in Drama and surroundings and another two in Kavala.

SMEs that indicatively can be targeted/directed:

- Hotel Grand Chalet: Between Drama and borders → [Location](#)
- Strada Cafe: Between Drama and borders → [Location](#)
- Commercial Center, ΚΟΥΤΑΣ ΚΩΝΣΤΑΝΤΙΝΟΣ & ΣΙΑ: Between Kavala and Drama → [Location](#)
- Super Market Γουντζιδης: Close to Drama → [Location](#)

Itinerary - Smolyan and Zlatograd to Xanthi

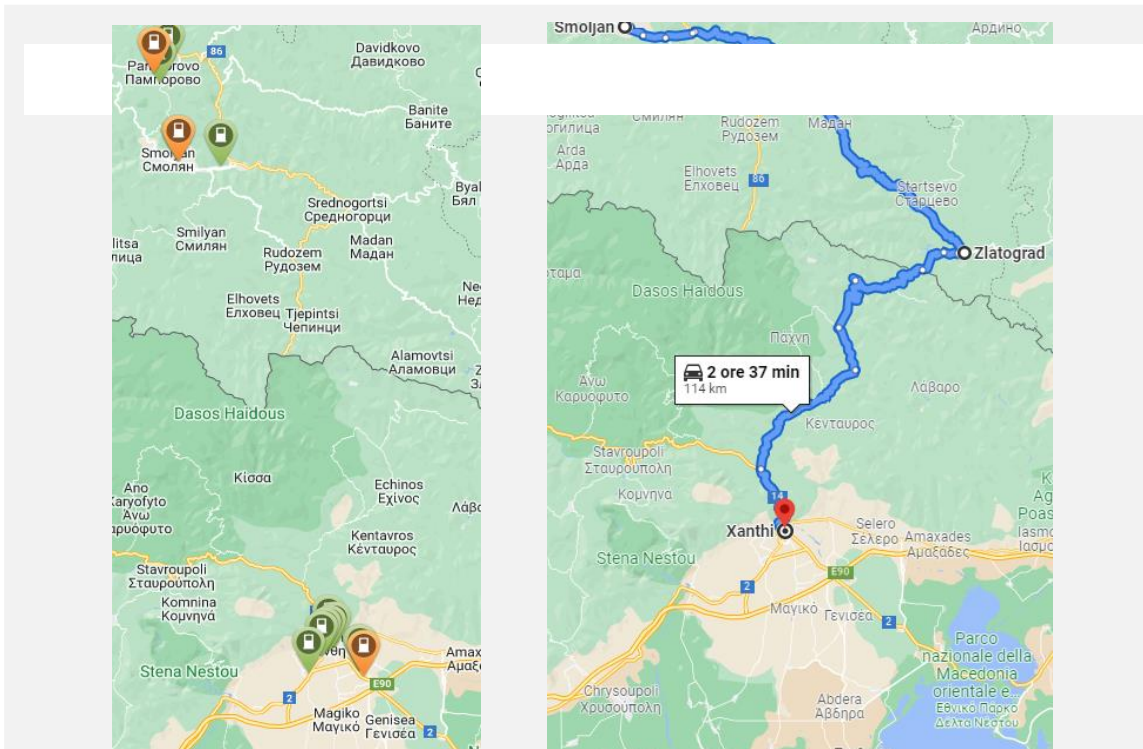


Figure 10: Itinerary - Smolyan and Zlatograd to Xanthi

There are 2 DC fast charging stations and 14 charging stations on this itinerary :

- 2 DC fast charging stations: 1 at Smolyan: CHAdeMO DCFC, CCS DCFC, cost: 0.45 €/ kWh; 1 at Xanthi: DC50kW CCS + DC50kW CHAdeMO, cost: 0.60 €/ kWh. Manufacturer: ELPE
- 14 AC charging stations

There are 114 km from Smolyan to Xanthi not covered with a DC fast charging station. At the same distance there is only one AC charging station. This itinerary requests another two charging stations in Smolyan, three in Zlatograd and two more near Xanthi

SMEs that indicatively can be targeted:

- Rhino Estate Coffee: Between Xanthi Zlatograd → [Location](#)
- Caffeine: Between Xanthi Zlatograd, at Echinus → [Location](#)
- Agriani Hotel: Close to Xanthi → [Location](#)
- Xanthippi Restaurant: Close to Xanthi → [Location](#)

Itinerary - Kardzali to Komotini

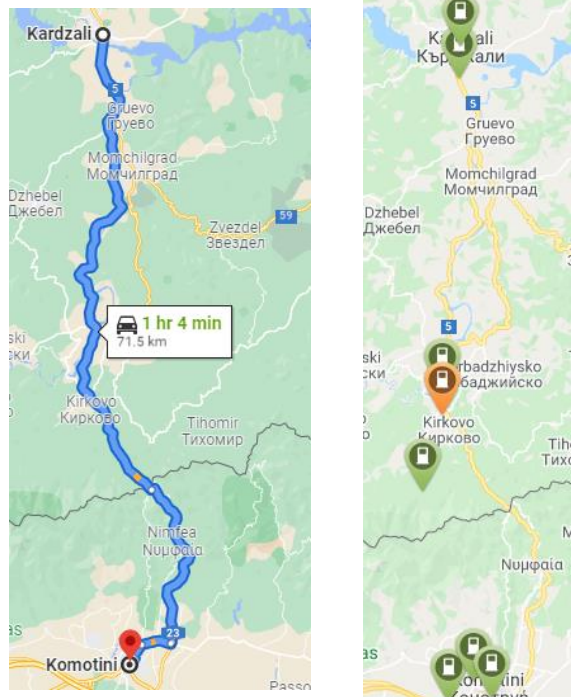


Figure 11: Itinerary - Kardzali to Komotini

There are 9 charging stations so far in the itinerary:

- 1 DC fast charging station in Kirkovo: CHAdeMO DCFC, CCS DCFC, cost: 0.45 €/ kWh
- 8 AC fast charging stations

The distance between Kardzali and Kirkovo is 40 km and from Kirkovo to Komotini - 38 km, but there aren't DC fast charging stations and the AC charging stations are not enough as well.

It will be needed two charging stations in Kardzali, two in Komotini and at least one more in Kirkovo.

SMEs that indicatively can be targeted:

- BEM Food: Between Komotini and borders → Location
- Tavern "Make a Stop": At Komotini → Location

Itinerary - [Svilengrad](#) to [Alexandroupoli](#)

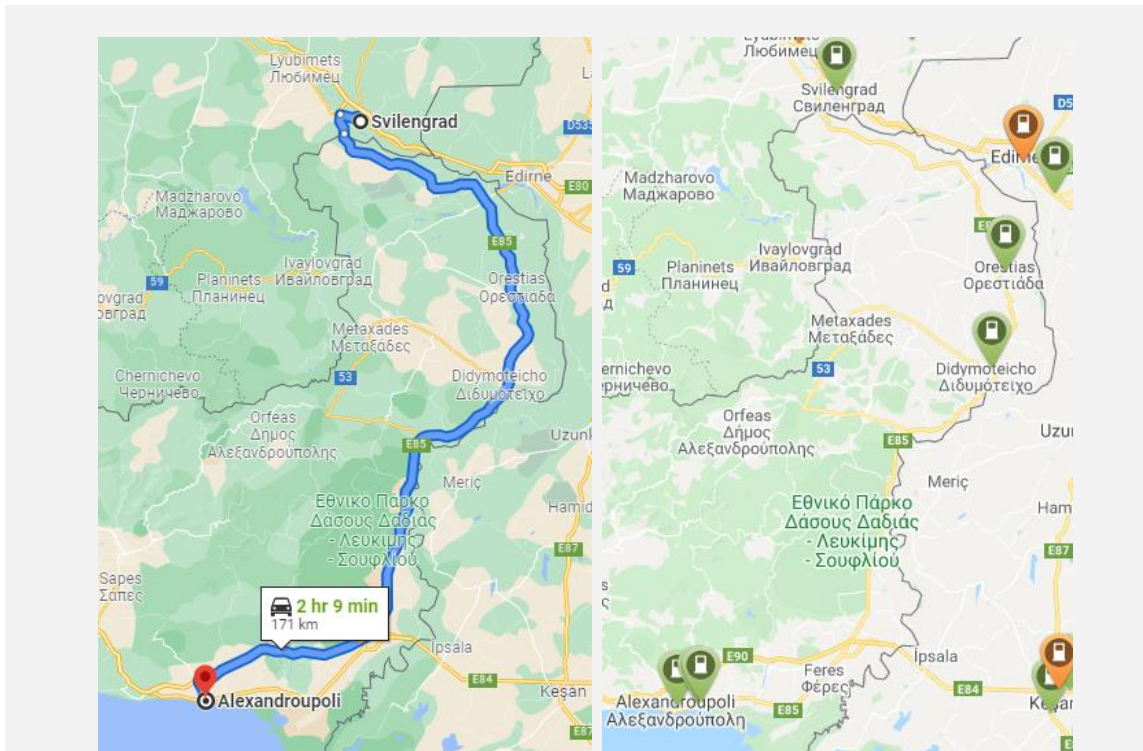


Figure 12: Itinerary - Svilengrad to Alexandroupoli

There are 8 charging stations:

- 0 DC fast charging stations
- 8 AC charging stations

There are 171 km from Svilengrad to Alexandroupoli without DC fast charging station. The AC charging station coverage is also poor.

This itinerary will need as minimum two charging stations in Svilengrad, one in Orestiada, one in Didymoteicho and at least two or three in Alexandroupoli.

SMEs that indicatively can be targeted:

- Hotel café la strada: Between Alexandroupoli and Didimotoixo → [Location](#)
- Η ταβέρνα των κυνηγών: At Soufli → [Location](#)
- Shopping mall METKE: Close to Didimotoixo → [Location](#)
- Tsiokos AE Rental – rent a car: Close to Orestiada → [Location](#)

V. BIBLIOGRAPHY

Statista. (n.d.). [https://www.statista.com/statistics/955443/number-of-electric-vehicle-charging-stations-in-europe/#:~:text=In%202020%2C%20there%20were%20roughly,in%20Europe%20\(including%20Turkey\).](https://www.statista.com/statistics/955443/number-of-electric-vehicle-charging-stations-in-europe/#:~:text=In%202020%2C%20there%20were%20roughly,in%20Europe%20(including%20Turkey).)

Wallbox. (n.d.). Retrieved from https://wallbox.com/en_catalog/faqs-difference-ac-dc

www.plugshare.com. (n.d.). Retrieved from plugshare.

Recharge EU: How many charge points will Europe and its Member States need in the 2020s.

European Court of Auditors: Special report 'Electric vehicle charging infrastructure'

General strategy for the development of the Electric Vehicles Industrial Cluster